

INTERACTIONS BETWEEN SOIL FAUNA OF A
BEACH FOREST AND WHITE DUNE

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ВЗАИМОДЕЙСТВИЯ МЕЖДУ ПОЧВЕННОЙ ФАУНОЙ ПРИБРЕЖНОГО ЛЕСА И БЕЛОЙ ДЮНЫ

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Introduction

Unique seaside dune complexes of Europe, or even the World situated in the Słowiński National Park - The World Biosphere Sanctuary provide invaluable material for theoretical and practical natural studies /1,4/.

The objective of this study was to estimate the dune stress (in the dune, forest and grassland microbiocenoses introduced into a white dune) by means of: a quantitative and qualitative analysis of the soil fauna, an evaluation of soil biological activity and floristic changes due to the experiment.

The study (W 10.2.10, MR 11-15) was coordinated with the Institute of Ecology - Polish Academy of Science, Dziekanów Leśny near Warszawa and the Department of Natural Resources Protection - Polish Academy of Sciences, Cracow /2,3/.

Methods

Control and experimental studies were carried out in 1980-1982. During the first year they comprised 20 different microbiocenoses (dune, forest, grassland) introduced into the white dune formed by wind-driven sand. The mobility and instability of white dune bed did not interfere with our experiment in which the following microbiocenoses were used (area 25x25 cm and depth 30 cm): forest - *Empetrum nigrum*, *Erica tetralix*, *Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Vaccinium uliginosum*, *Cladonia* sp., *Calluna vulgaris*, *Myrica gale*, *Ledum palustre*, *Polytrichum* sp. (large and small), *Oxycoccus*

quadripetalus, Sphagnum sp.; dune - Salix arenaria, Carex arenaria, Ammophila arenaria, Festuca ovina; grassland - near forest (Deschampsia caespitosa), degraded (Poa pratensis), cultivated (Alopecurus pratensis). Later on (in 1981-1982) the investigations were repeated with only 10 forest microbiocenoses, as follows: Empetrum nigrum, Erica tetralix, Vaccinium myrtillus, Vaccinium vitis-idaea, Vaccinium uliginosum, Cladonia sp., Ledum palustre, Oxycoccus quadripetalus, Polytrichum sp., Sphagnum sp.

To evaluate soil biological activity, cellulose drains were placed under each introduced microbiocenosis and into the control plots. The difference between the initial and final dry weights showed the rate of cellulose decomposition in soil - a measure of the biological activity (A,%).

Faunistic studies included: soil samples (control and experimental) of 25x25x30 cm at 0-10 cm, 10-20 cm and 20-30 cm levels; soil traps (Barber's), 7 cm in diameter, buried around the investigated microbiocenoses (one on each side).

The following indicators were used in the faunistic analysis: relative population density; species dominance; species stability within the studied microbiocenoses; modified Sørensen's index, applied for comparing the fauna of individual microbiocenoses.

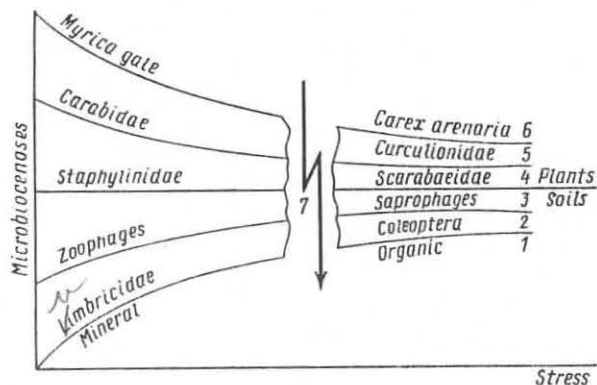
Results

Floristic Changes Resultant of Dune Stress (Introduction). Characteristic vegetation of individual microbiocenoses generally covered 100% of the area. The introduction caused significant changes in vegetation.

The vegetation on fertile and humid soils (ground-swamp, transition peat-bog and podzol soils) in forest biotops withered completely or covered much smaller area than before. In some cases the area having been vacated by Empetrum nigrum, Erica tetralix, Ledum palustre was substituted by dune vegetation Carex arenaria, Festuca ovina. Nevertheless, Empetrum nigrum and Erica tetralix adjusted well to the dune stress conditions. In the grassland microbiocenoses (near-forest, degraded, cultivated) a rapid introduction-induced development of Graminae was initially observed. On the other hand, no significant changes were noted in the vegetation of introduced dune microbiocenoses except that Salix arenaria withered intensively.

Soil Biological Activity in the Control and Experiment. The cellulose decomposition rate increased significantly from the microbiocenoses of the white dune to the grey dune ones and further to the microbiocenoses of the typical seaside forest (Empetrum nigrum-Pinetum typicum), reaching 8% A in the white dune, 14.9% A in the grey dune, and 30% A in the seaside forest.

Similar proportions in the cellulose decomposition rate were observed in the experiment. However, the biological activity of introduced soils was lower than that of the control. This was due to the introduction-induced ecological stress and the influence of nearly sterile original bed (initial soils). Low biological activity was recorded in the mineral soil microbiocenoses (Salix arenaria, Carex arenaria, Ammophila arenaria), and the highest in the typical organic soil ones (Vaccinium myrtillus, Myrica gale, Sphagnum sp., Poa pratensis, Alopecurus pratensis). The other introduced microbiocenoses had average biological activity (15-33% A).



Interaction between soil fauna of beach forest and white dune
- dune stress of seaside microbiocenoses soil fauna

1 - soil (mineral-organic, biological activity), 2 - faunistic communities (Lumbricidae-Coleoptera), 3 - trophic groups (zoophages-phytophages-saprophages); Coleoptera families: 4 - Staphylinidae-Scarabaeidae, 5 - Carabidae-Curculionidae, 6 - vegetation (forest, grassland, dune), 7 - introduction of microbiocenoses

Dune Stress: Introduction-Induced Faunistic Changes. Dune stress was caused by the introduction, as well as intensive insolation, considerable temperature variations, low humidity and compactness of soils and marked activity of mechanical factors (sands covering and uncovering). The stress was mainly responsible for the lower fauna relative density, especially in forest microbiocenoses, and increase of Coleoptera and Diptera accompanied by decrease of Hymenoptera, Arachnida and Lumbricidae. The groups rare in the control (Blattodea, Heteroptera, Collembola, Neuroptera) were not found in the experimental conditions. Within Coleoptera, Elateridae, Carabidae, Staphylinidae and Scaphidiidae were less abundant, whereas the number of Scarabaeidae and Curculionidae increased. Some new species (absent in the control) were also found, as follows: Amara apicaria Payk., Harpalus neglectus Dej., Pterostichus cupreus L., Aegialia arenaria Fabr., Anomala aenea Deg., Melolontha melolontha L., Philopodon plagiatus Schall., Athous niger L. The species variability of Coleoptera, as compared to the control, increased in the following microbiocenoses: Empetrum nigrum, Vaccinium vitis-idaea, Oxycoccus quadripetalus, Alopecurus pratensis, Erica tetralix, Vaccinium uliginosum.

Coleoptera larvae were found to dominate over adults and pupae in the control, whereas imago dominated in the experimental plots. The most frequent pupal forms belonged to Elateridae, Diptera and Curculionidae.

In the vertical distribution of introduced soil fauna no significant changes were observed. The abundance of faunistic communities decreased from 0-10 cm to 10-20 cm, to become occasional at 20-30 cm deep samples.

The dune stress caused higher relative density of phytophages, and especially saprophages, whereas the density of zoophages decreased (Fig.).

Conclusions

The experiments try to explain the destructive activity of shifting dunes (stresses, ecological catastrophes) and suggest the following conclusions:

Dune vegetation entered the organic soil microbiocenoses enrich them floristically.

Biological activity of introduced soils increased or slightly decreased only in soils with high organic substance contents.

Dune (ecological) stress caused a general reduction in fauna and flora of the introduced microbiocenoses and an emergence of dune species (Carex arenaria, Festuca ovina..., Philopodon plagiatus, Aegialia arenaria, Harpalus neglectus...).

Ecological catastrophes induced by the introduction of microbiocenoses into the white dune reduced mainly water content and food supply thus inhibiting the development firstly of zoophagous, and then of phytophagous and saprophagous populations.

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